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ECBC memo dtd 14 Apr 2015

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HISTORY OF RESEARCH AT YALE UNIVERSITY

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Yandell / Henderson

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INFO. Div., GWS Tech. Cond., EIA

The Director,
Bureau of Mines,
Washington, D.C.

History of Research at Yale University.

In conformity with your letter of May 3 requesting a progress report on the work in my charge under the Bureau of Mines for the War and Navy Departments, I have the honor to submit the following:

Mechanical Engineering Division. W.E. Gibbs, Chief.

Mr. Gibbs completed some time ago the designs and tests for an absorber to remove carbonic acid from the air of submarines. He has been working lately on the oxygen apparatus allotment from the Aviation Section Signal Corps, and has developed now I believe to its final form a device for supplying oxygen to aviators to allow them to go to great altitudes. I am confident that this apparatus will be at least as efficient as the so-called Dreyer apparatus of the British and French, several thousand of which are now under construction, and that, owing to its comparative simplicity, it will be possible to construct it more cheaply, much more rapidly than the foreign apparatus. It is particularly adapted to quantity production, while the foreign apparatus has heretofore always been made one at a time and by hand. I would respectfully recommend that the Gibbs apparatus should be put into production at the earliest possible date.

Dr. J.E.A. Eyster has developed a mask for aviators to hold a wireless telephone transmitter and to provide also for the inhalation of oxygen, for use under the oxygen apparatus allotment.

Medical Research Laboratory, Hazelhurst Field, Mineola.

Medical Research Board: Yandell Henderson, Chairman.

Present personnel of laboratory. 54 officers, 32 non-commissioned officers and privates, Lieutenant Colonel W.H. Wilmer, Commanding Officer; Major E. G. Seibert, Executive Officer.

The purpose of this laboratory is to develop methods of testing and preserving the health and efficiency of aviators. At present it is stated that as little as a total of 150 hours of flying above 15,000 feet renders an aviator unfit for further flying over the lines and endangers his life if he persists. A very large percentage of British and French aviators are reported to be thus incapacitated, and the majority of those who lose their lives do so because of fainting in the air or becoming neurasthenic.

Working with an apparatus, the so-called Henderson rebreathing apparatus of my invention, we have developed at this laboratory tests by which the altitude to which each particular aviator can safely go is easily determined without any risk to his life or health. By means of an examination of each aviator every few weeks it will be possible to prevent the greater number of the fatalities which now result in the case of men who, having gone stale, persist in flying, and are killed in consequence.

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Smaller laboratories for the application of the methods are being erected at ten other aviation fields, and it is planned to have a similar testing laboratory erected at all of the aviation fields.

Work is also under way at this laboratory on improvements in the methods of testing the aviators' sense of equilibrium and on other matters bearing upon the fitness of men for work in the air. This work is in the immediate charge of Major Lewis, Captain Dunlap and Prof. Pike, the latter on Bureau of Mines consulting appointment.

Division of Gas Factory Sanitary Inspection and Protection.

Captain H.C. Bradley, Chief. 5 contract surgeons, 5 lieutenants, M.R.C., 2 civilians on mechanical research.

This division protects the health of the men in the war gas experiment station at the American University, Washington, and also provides sanitary supervision and protection at all factories manufacturing poisonous gases for the Army. Cover-all suits have been developed, and a very dangerous occupation has been rendered practically safe. It is believed that except in cases of individual carelessness an industry which is destined to grow within the next few months to very large proportions can be kept practically free from fatalities.

Literature Division: Dr. Clarence J. West, War Gas Experiment Station, American University, Washington.

Dr. West is engaged in collecting and compiling the entire literature bearing upon the medical and physiological side of poisonous gases.

Toxicological Division: First Lieutenant E.K. Marshall, S.C.N.A.
2 lieutenants, 24 privates, 3 civilians.

This division performs the extremely important task of determining the toxicity and availability for military use of all new poisonous gases produced by the chemists. A total of more than 150 new substances have already been studied and intensive work on the toxicological properties of mustard gas, etc., is under way.

This division is to be reorganized and enlarged under the general supervision of Prof. Reid Hunt in order that it may be able to keep up with the rapidly increasing volume of work.

Gas Shell Proving Ground (Lakehurst, N.J.) Captain Wm. S. Bacon, S.C.N.A.

At the last report there were about 200 officers and men under Captain Bacon. At the proving ground gases which have been found in the laboratory to be promising for military use will be fired in shells on a sufficient scale to determine the conditions for their efficient use in the field. The conditions of actual warfare with trench system, etc. will be reproduced but with animals (goats and dogs) in the trenches instead of men. Although the ground was only taken over about 6 weeks ago the chemical and pathological laboratories are nearing completion and firing is expected to be under way at an early date.

Therapeutic Division. Prof. F. P. Underhill
 Pathological Division. Maj. M. C. Winternitz, M.R.C.
 Physiological Research Division. Lieut. H. W. Haggard, S.C.N.A.

These divisions include at the present time 3 sergeants, 2 corporals, 12 privates, 15 civilians, employees of the Bureau of Mines. These divisions are working in the laboratories assigned to the Government by Yale University, New Haven, Conn.

The therapeutic division is working on the development and improvement of methods for treating gas poisoning and particularly pulmonary edema. When a man has inhaled even a small amount of one or other of the poisonous gases now used in war the irritation of his lungs causes them after a short time to become inflamed so that fluid is poured out into the air sacs and he practically drowns in the fluid, - a condition of so-called pulmonary edema. To prevent the development of this condition Prof. Underhill and his co-workers have developed a method depending upon venesection and intravenous injections of saline, which in experimental animals has proved capable of decreasing the mortality of an otherwise lethal concentration of gas by 50 per cent or better. Two men. Lieutenants Wilson and Goldschmidt have been sent to France to introduce this method, and they are now at work at Porton, the English experimental station, demonstrating the capabilities of the method.

Under Dr. Underhill's direction also investigations are going forward regarding the treatment of gas cases with oxygen. This is the treatment which the English particularly use at the present time to the exclusion of all others. The results of the investigations in New Haven however tend to show that although the administration of oxygen produces some relief of the symptoms, it does not reduce the mortality. The question of the expenditure of a large amount of money for oxygen inhalers to be sent to the American troops will turn upon the final outcome of this investigation.

In the physiological research division investigations are under way on the changes in the blood occurring under gassing and under shock. The results obtained show the character of the change and have given valuable leads in the direction of methods for counteracting shock. These results were reported at the recent meeting of the Physiological Committee of the National Research Council, which is in touch with the British committee of the same sort.

Under Major Winternitz all animals dying as the result of gassing in New Haven or in the gas laboratory at Washington are autopsied and the character of the changes studied in gross and microscopically. Among men who are gassed a considerable percentage of those who survive the first few days later develop pneumonia and other pulmonary troubles. The investigations under Major Winternitz have already demonstrated that the source of the infection is the bacteria of the subject's own mouth. Investigations are under way to determine the possibility of so sterilizing the mouth as to avoid these intercurrent infections and for the development of other methods of treating these cases.

Division for the Study of Chronic Gas Poisoning. In charge Dr. A. S. Loevenhart, University of Wisconsin.

Experience has already shown that small concentrations of gas over a considerable period of time produce effects distinct from the more acute effects. Cases of this sort are common in factories making poisonous chemicals, and it

appeared certain that they would occur in factories producing poisonous gases for use in war. Under Dr. Loevenhart's direction a number of the chemists and physiologists of Wisconsin University, assisted by a group of students who stand the night watches, have been conducting experiments on prolonged intoxication with low concentrations of gas on dogs, and have obtained results which will be very useful in the protection of the workmen in factories, as well as having bearings on gassing occurring on the battlefield.

Similar volunteer investigations in cooperation with the general purpose of the work of the Bureau of Mines are under way at the University of Minnesota and at Western Reserve University, Cleveland.

Special Consultation Work. by Yandell Henderson.

Some months ago I made an investigation of the air in submarines and demonstrated the occurrence of a sufficient amount of carbon monoxide to explain the headaches and lassitude and occasional so-called "gasoline jags" occurring among the crews of these vessels. This was the basis of a special report to the Surgeon General of the Navy.

Under my direction Prof. L. F. Rettger has worked out a method of disinfecting gas masks, which is now being put into use at the cantonments in connection with anti-gas training of the troops.

I act also in an advisory capacity to the divisions at the American University and to the Gas Defense Service on technical points regarding the amount of resistance allowable in masks and other details of constructing bearing upon the comfort and welfare of the men who are to wear them. The high resistance to breathing was a great handicap upon the British in the recent fighting when they had to wear their masks for days at a stretch, and it is, in my opinion, extremely important to develop masks which may be worn with comfort, and in which a man can perform maximum exertion, work his gun, and otherwise carry on. Modifications of the American mask along these lines are under way.

All of which is respectfully submitted.

YANDELL HENDERSON.

COPY

New Haven, Conn.
November 20, 1918

Major H. C. Bradley
Chemical Warfare Service
7th and B Streets, N.W.
Washington, D.C.

Dear Harold:

As requested in your letter of November 13 I will try to put together some notes on the beginning of the medical science divisions of the Gas Investigations. It happens however that in the spring and summer of 1917 I went to Washington every week and therefore wrote very few letters and have almost no memorabilia. I have written to Director Manning asking for a list of every one appointed physiologists or junior physiologists in the Bureau, with dates of appointment. I will send you this as soon as I obtain it, or perhaps you can get it direct from Mr. Bailey.

Please excuse the desultory and, as I fear it will be, highly personal account which follows.

My connection with the Bureau of Mines began in 1912. There had been a commission on resuscitation from electric shock appointed by the electric light industries and the American Medical Association. Director Holmes of the Bureau of Mines requested the physiologists of this commission to make a similar report to the Bureau of Mines on mine gases (Technical Paper 77, 1914). After the commission had reported I was on nomination of Dr. W. B. Cannon appointed consulting physiologist in the Bureau of Mines. I am sending under separate cover a reprint of two papers which I published in the Journal of the A.M.A. in 1916, showing the lines along which I worked; also a copy of Technical Paper 82 on mine rescue apparatus, which was published in 1917 only a few weeks before America declared war.

In this work for the Bureau I had been particularly associated with G. A. Burrell, W. E. Gibbs, and J. W. Paul. Accordingly when war became inevitable Director Manning offered the services of the Bureau of Mines to the Council of National Defense for the development of chemical warfare, and he telegraphed to the above mentioned group, together with Mr. Fieldner, and one or two others to come to Washington for a conference. The date was some time late in March, but I have no exact record of it.

Mr. Burrell and I undertook the organization work. Mr. Paul soon dropped out except for occasional assistance on engineering matters, while Mr. Gibbs devoted himself particularly to technical questions regarding the construction of the gas mask. Mr. Burrell and I at that time were in contact chiefly with Major, now Colonel, L. P. Williamson, M.C. of the General Staff.

About May 10 we received telephone order from Major Williamson to provide 20,000 gas masks. We had already enlisted the voluntary cooperation of many chemical laboratories around the country to test charcoal and other absorbents, and we had canvassed the situation with regard to a permanent station. May 24 Dewey, Gibbs and I went to Akron to make the arrangements with the Goodrich Rubber Company for the rubber parts of the first mask, and then returned to New York, where Dewey and Gibbs arranged for the metal parts.

On June 10 the first half dozen masks were ready for test. They were tried out by Dewey, Burrell and myself on the baseball diamond in Brooklyn across the street from the American Can Factory.

That night Dewey and I went to Pittsburgh with a number of canisters and the half dozen face pieces which were completed. Mr. Fieldner and about a dozen of his assistants were at work in a shed in the old arsenal grounds where the Bureau of Mines was then placed, testing absorbents and developing apparatus for testing canisters. You will understand that the first contingent of American troops were to sail for France in a short time and that it seemed essential that they should be supplied with gas masks. The factories were ready to begin production as soon as we approved the model, represented by the few canisters and face pieces which we had.

It was essential that tests on men should be run. We had heard so much of the terrors of gas in the newspapers that everyone naturally felt some qualms on this aspect of the work. It seemed to me that it was my duty to take the lead and on June 10 therefore when I reached Pittsburgh I asked Mr. Fieldner and Mr. Paul to have one of the gas chambers in the grounds at the arsenal prepared for this test. Compared to such tests as we have now learned to run it was crude and I think extremely dangerous. As I look back on it it seems probable that if the mask had not afforded protection I would have been severely gassed, but I was determined that the test should be one which would exceed in severity anything to which the masks would be subjected while our soldiers were wearing them. It seemed to me the one time at which I could expose myself properly to personal danger in the cause of the war. The chamber contained as Mr. Fieldner calculated it 16800 liters of air, into which we put two large glass bottles, tubulated at the top and bottom, full of chlorine. Then I put on the mask, went into the chamber, shut the door and opened the bottles. I remember the warm feeling as the chlorine flowed down over my feet. I stayed in there 15 minutes. I realized afterwards that I was pretty thoroughly scared. The gas bleached my socks and (air and aided by perspiration acted on my undershirt so that it pulled to pieces when I later took it off. Toward the end of the 15 minutes I took the mouthpiece out of my mouth with the mask still on and tried speaking to see whether I would still be protected.

I mention all this because later on these masks were found to have certain defects, and a very harsh report was sent back from France. These defects we had ourselves discovered, but even so I was and am still of the opinion that these early masks, considering all the conditions, were an excellent product. Colonel Burrell can supply you with information on this matter.

On this date also we were asked to supply specifications and drawings for an oxygen inhalator. This was planned by Mr. Paul, Mr. Gibbs and myself and was adopted, and has been I believe used successfully in France. (An inferior form of apparatus was also reported from France, but on investigation was proved to have been supplied from England.)

During May and the early part of June Burrell, Dewey, Lewis and I looked around the environs of Washington and also visited the Pickatanny Arsenal and considered places in Delaware and elsewhere for a station for the Gas Investigations. Finally the American University was selected, but it was decided that in the meanwhile the chemical work should be developed under Mr. Fieldner at the Pittsburgh station and that the medical science work should be developed here in New Haven.

I made arrangements with the state government to obtain all the stray dogs taken up in the western half of the state. The University allowed us to take the Yale Field and remodel the athletic club house. Underhill was placed in charge of the section on metabolic disorders induced by gas, and called Samuel Goldschmidt and David Wright Wilson as his assistants. H. G. Barbour was appointed in charge of the pharmacological section, and Marshall and later Kolls were brought here. Harold F. Pierce, who had lately been an assistant of Cannon, Arthur H. Smith, who had been a graduate student here, and others were appointed. In particular H. W. Haggard was given charge of the work, at that time very active, on the determination of the toxicity of different substances on mice. The development of the apparatus for this purpose was largely due to him.

From the beginning I laid down one or two general principles to which we adhered pretty closely, namely that as we were not rushed as the English and French had been the work done should be of as high grade a scientific character as possible, in particular that the gassing should be as accurately quantitative as possible. The apparatus which has come to be used originated in this way. I saw in Pittsburgh the arrangement which Fieldner was using for testing canisters and the way that he was using flow meters, etc. By the time we opened the laboratory at Yale Field, about the 20th or 25th of June, 1917, I had drawn up a plan for a gassing apparatus with a continuous flow of air. This I believe differs from anything that has been used on the other side of the ocean. It was at first somewhat leaky and I remember one day when I was called out to Yale Field by a report that men were being gassed, and found pretty nearly the whole force in a state of panic. The plan of having the chamber ventilated, the hood ventilated separately, and the room ventilated again separately was the result of this. Underhill, Marshall and Barbour all contributed to the perfection of this apparatus, which has been the basis for all of the animal investigation that has since been done.

As you know Underhill found that animals which he was using merely for observation and study, without any intention of treating them, proved to be more resistant than others which he did not study. As the only treatment which he gave was the withdrawal of blood for analysis this furnished a hint out of which his work developed. In September it seemed best that Marshall and his group should move to Washington. The other work was continued here.

I might add that during the summer Harold F. Pierce was at work partly here and partly in Pittsburgh on the improvement of the mask. He was later transferred to the aviation investigations.

Early in August William S. Bacon, a former student of mine, came here and was put to work as a laboratory assistant. In the course of a few weeks I advanced him to a general manager of the New Haven station in regard to all business matters when I was away. At the time there was a regular weekly meeting in Washington of a large committee, including Maj. L. P. Williamson and Captain Ragsdale, at which plans were made. When we were informed that the Army intended to manufacture and use poisonous gases, Captain Ragsdale put up to me the question of methods of determining the efficiency of their use in the field. I suggested that it would be necessary for me to put this matter in charge of some one whose work I should merely supervise. Because of his versatility I proposed Bacon.

We made a little demonstration of a kind of mouse trap with electric contacts which proved so impressive to the committee that our plans were approved. I need scarcely say that the mouse trap has never been used since. Early in the autumn Bacon moved to Washington, as he then expected to carry out shell tests etc. near the American University. He can supply you with a more definite account of his doings than I can furnish.

As soon as I understood that the Army was to manufacture gases I realized that there would be an immense amount of industrial poisoning, and it was to meet this need, as my letters to you show, that I wrote to you.

I do not know whether you wish to go into the aviation side of the work, but that really was an outgrowth of the medical divisions of the gas investigations. You will find an account of the scientific side of this work in the Journal of the A.M.A. for October 26, 1918. It seems to me that in your report at least a mention of this work and of the names of E.C. Schneider, James L. Whitney, Harold F. Pierce, and Knight Dunlap might advantageously be included. The Medical Board of the Air Service was of course outside of the gas organization, but the men who did the actual work in the laboratory, Schneider, Whitney, et al worked for a time at the American University and I think deserve mention.

I would be glad if you would ask Mr. Fieldner for an account of the first gas mask test, as the one time in my life that it has come my way to face real danger in the public service was on that occasion, and as I look back on it I think it was a real danger.

Regarding my activities I might mention that I was two or three nights in a train for the greater part of the first year, and on one occasion got up as high as five out of eight nights.

Most of the foregoing is just personal detail which you won't want to use, and which probably will be of no interest to anyone but me, but I have dictated it just as it came to my mind from such scattered memoranda as I can find.

By the way, an acknowledgment of the splendid support given by Yale University in regard to Yale Field and in regard now to the new Laboratory which is to be fitted up here is I think proper.

Cordially yours,

YANDELL HENDERSON



DEPARTMENT OF THE ARMY
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
EDGEWOOD CHEMICAL BIOLOGICAL CENTER
5183 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MD 21010-5424

REPLY TO
ATTENTION OF:

APR 14 2015

RDCB-DPS-RS

MEMORANDUM THRU Director, Edgewood Chemical Biological Center (ECBC),
(RDCB-D, Mr. Joseph L. Corriveau), 5183 Blackhawk Road, Aberdeen Proving Ground,
MD 21010-5424

FOR Office of the Chief Counsel, US Army Research, Development and Engineering
Command (RDECOM), (AMSRD-CCF/Ms. Kelly Knapp), 3071 Aberdeen Boulevard,
Aberdeen Proving Ground, MD 21005-5424

SUBJECT: Operations Security/Freedom of Information Act (FOIA) Review Request

1. The purpose of this memorandum is to recommend the release of information in regard to request to RDECOM FOIA Requests FA-14-0054.
2. ECBC received the request from Ms. Kelly Knapp, the RDECOM FOIA Officer. The request originated from [REDACTED] gathering information on the Chemical Warfare Service.
3. The following documents were reviewed by Subject Matter Experts within ECBC:
 - a. History of Research at Yale University, dated 20 Nov 1918, 11 pages.
 - b. Bancroft's History of the Chemical Warfare Service in the United States, by Lt. William Bancroft; AD-495049; dated 31 May 1919, 206 pages.
 - c. A Historical Sketch of Edgewood Arsenal, by Lt. William McPherson; AD 498494; date unknown, 20 pages.
 - d. The Diary of Jet Parker; C390D1; dated Sep - Dec 1918, 26 pages.
 - e. American University Technical Reports, Bureau of Mines, War Gas Investigations (WGI) Monographs, date unknown.

RDCB-DPS-RS

SUBJECT: Operations Security/Freedom of Information Act (FOIA) Review Request

4. ECBC has determined that all of the reviewed documents are suitable for release, however, all documents must have the classification/distribution changed through the Defense Technical Information Center prior to any release.

5. The point of contact is Mr. Ronald L. Stafford, ECBC Security Manager, (410) 436-1999 or ronald.l.stafford.civ@mail.mil.



RONALD L. STAFFORD
Security Manager